

WHAT IF ELECTRICITY FROM WOOD COSTS 2 EURO CENTS / kWh AND PRODUCES HIGH QUALITY CHARCOAL?

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Among the renewable energy sources to generate electricity, the combustion or gasification of biomass could play an extremely important role in the future. A major reason for its importance is the independence between the time of availability of the energy source and power generation. However, to maintain their importance in the long run, correspondingly low leveled cost of electricity (LCOE) are necessary; the technology used must also be able to operate profitably without subsidized renewable energy feed-in tariffs.

The aim of this work is to reduce the LCOE of biomass combined heat and power-plants with a gasification reactor –wood gasification plants in particular – by utilizing or increasing the value of the gasification residue and a favorable input material. Essentially, the gasification residue is refined into a higher quality product so that the charcoal has the properties of an activated carbon (AC). Furthermore, waste wood (untreated pallets and packaging wood) should be treated in such a way that the resulting fractions can be processed in an existing reactor with the floating fixed-bed gasification (FFBG) technology. Therefore, a "Functionalization Unit" (Green Carbon Unit (GCU)) and treatment processes for waste wood are to be developed.

In addition to the possibility to process waste wood in FFBG systems ecologically and economically, the GCU makes it possible to adjust the quantity and product quality of the resulting charcoal to a different market requirement. This allows, for example, a partial load operation with increased and a full load operation with lower charcoal production in order to meet regional needs and demanded load profiles.

As you can see in Table 1, the fuel costs account for more than 50 % of LCOE, the processing of waste wood chips reduces production costs by approx. 50 %. In addition, by refining the charcoal into activated charcoal, a further reduction of approx. 50 % (trading price AC approx. € 1 kg⁻¹) can be achieved.

Framework conditions for the calculation of the LCOE:

- The calculation is based on a 500 kW_{el} plant.
- All costs and revenues are calculated on € cents / kWh_{el}.
- The district heating or local heating grid is not included in the investments.
- "Only" the high temperature heat (HTH) is calculated as revenue.
- Low-temperature heat is used as a drying heat.
- Ratio kW_{el} / kW_{HTH} is about 40 / 60.
- For the heat revenue 4 € cents / kWh_{HTH} be calculated, representing 6 € cents / kWh_{el}.
- The charcoal revenues will be charged at 200 € / ton_{DM} (Table 1) and 1000 € / ton_{DM} (Table 2).
- The fuel costs are set at 85 € / ton_{DM} (Table 1) and 25 € / ton_{DM} (Table 2).

Table 1: LCOE of a standard FFBG

invest	+ 5 € cent/kWh
financing	+ 1 € cent/kWh
operation & maintenance	+ 3 € cent/kWh
fuel	+ 7 € cent/kWh
heat revenue	- 6 € cent/kWh
charcoal revenue	- 1 € cent/kWh
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electricity costs	+ 9 € cent/kWh

Table 2: LCOE of the FFBG with waste wood and GCU

invest	+ 5 € cent/kWh
financing	+ 1 € cent/kWh
operation & maintenance	+ 3 € cent/kWh
fuel	+ 2 € cent/kWh
heat revenue	- 6 € cent/kWh
charcoal revenue	- 4 € cent/kWh
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electricity costs	+ 2 € cent/kWh

The pre-treatment of waste wood and the post-treatment of the charcoal reduce the LCOE of gasification plants – of a FFBG system in particular – from currently € 0.09 kWh⁻¹ by approx. 75 % (here commercial activated carbon as a by-product) to € 0.02 kWh⁻¹ (Calculation shown in Table 2).

According to the current state of the art, the use and appreciation of gasification residue is an under-explored area. In particular, to date, no systems are known which perform an "inline/in-situ" decentralized activation of the gasification residue and used as input material waste wood.